Improving soil health on working lands and the role of NRCS

Southern Regional NCSS Conference
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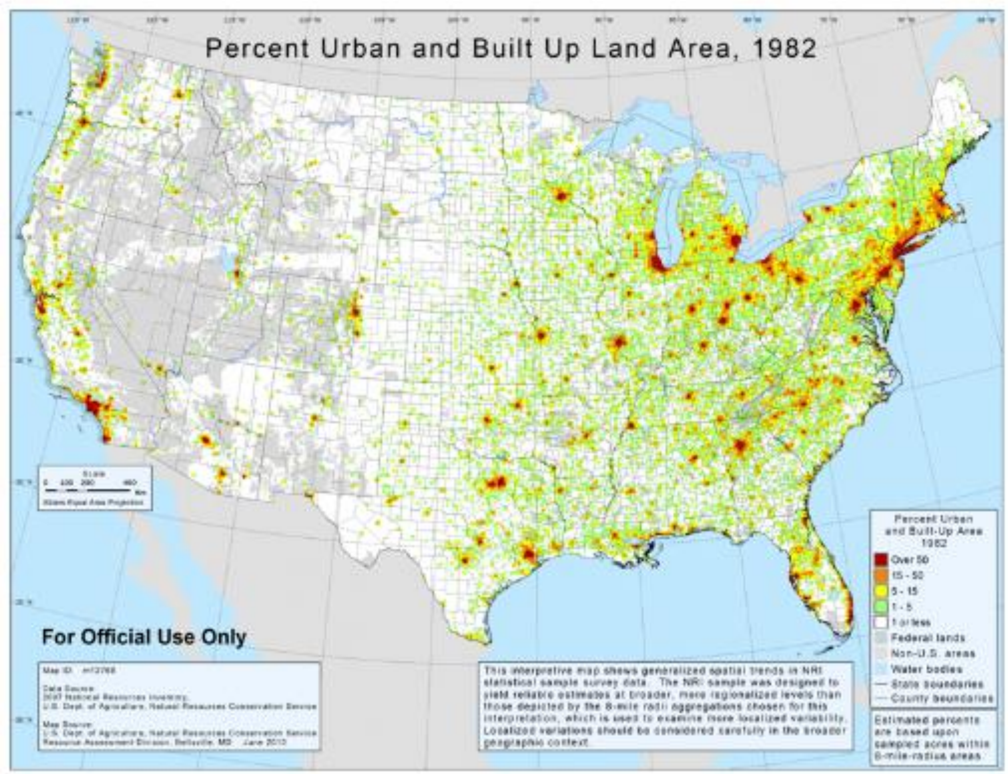
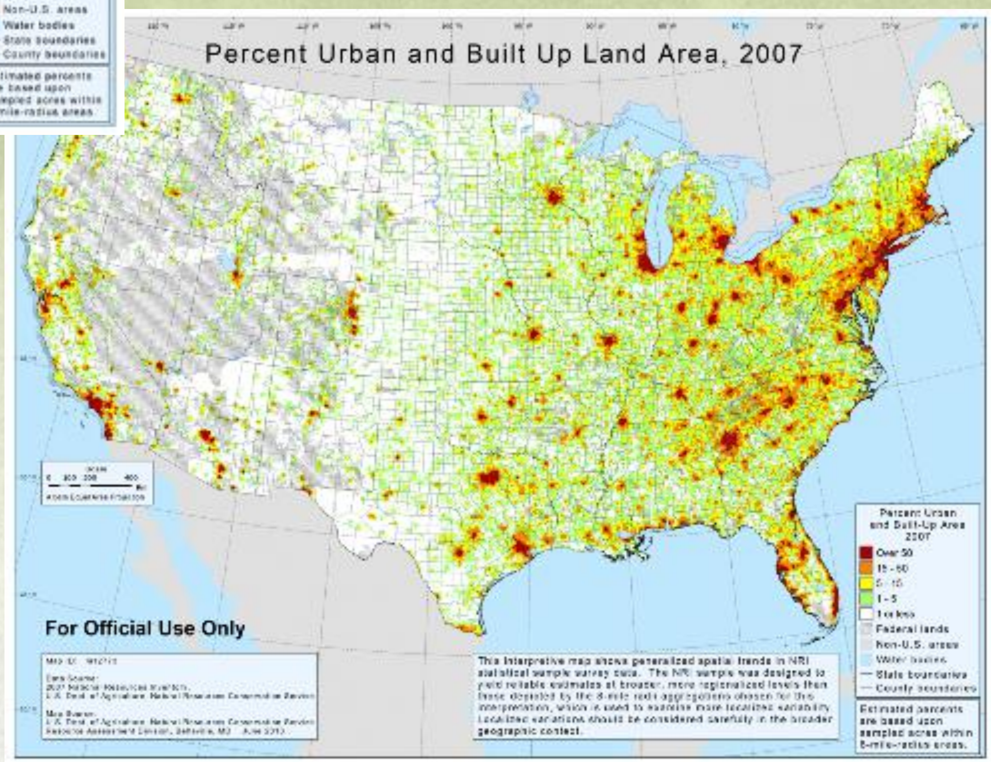
Southeast Region Team Leader

Challenges facing us in the 21^{st} century

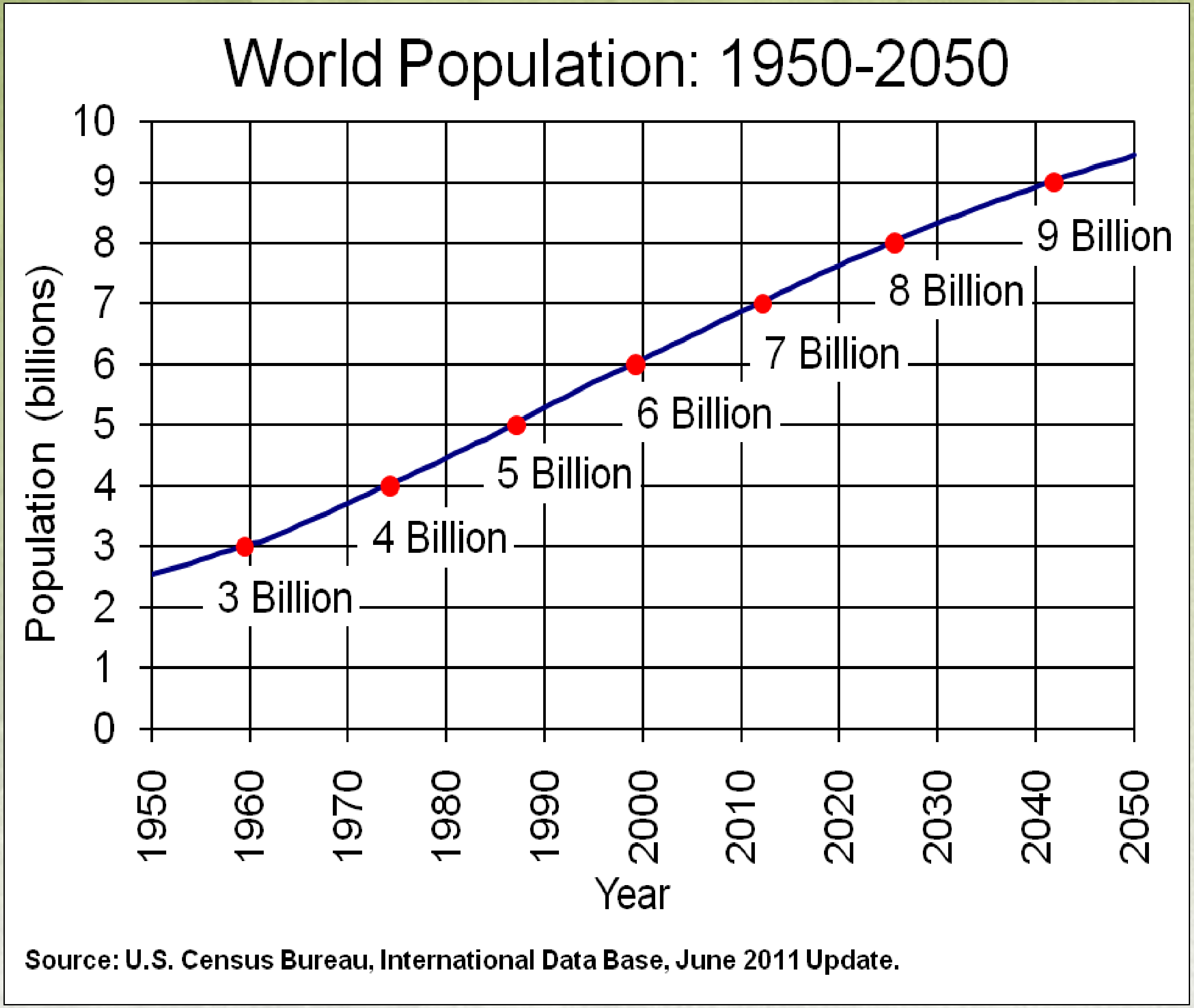


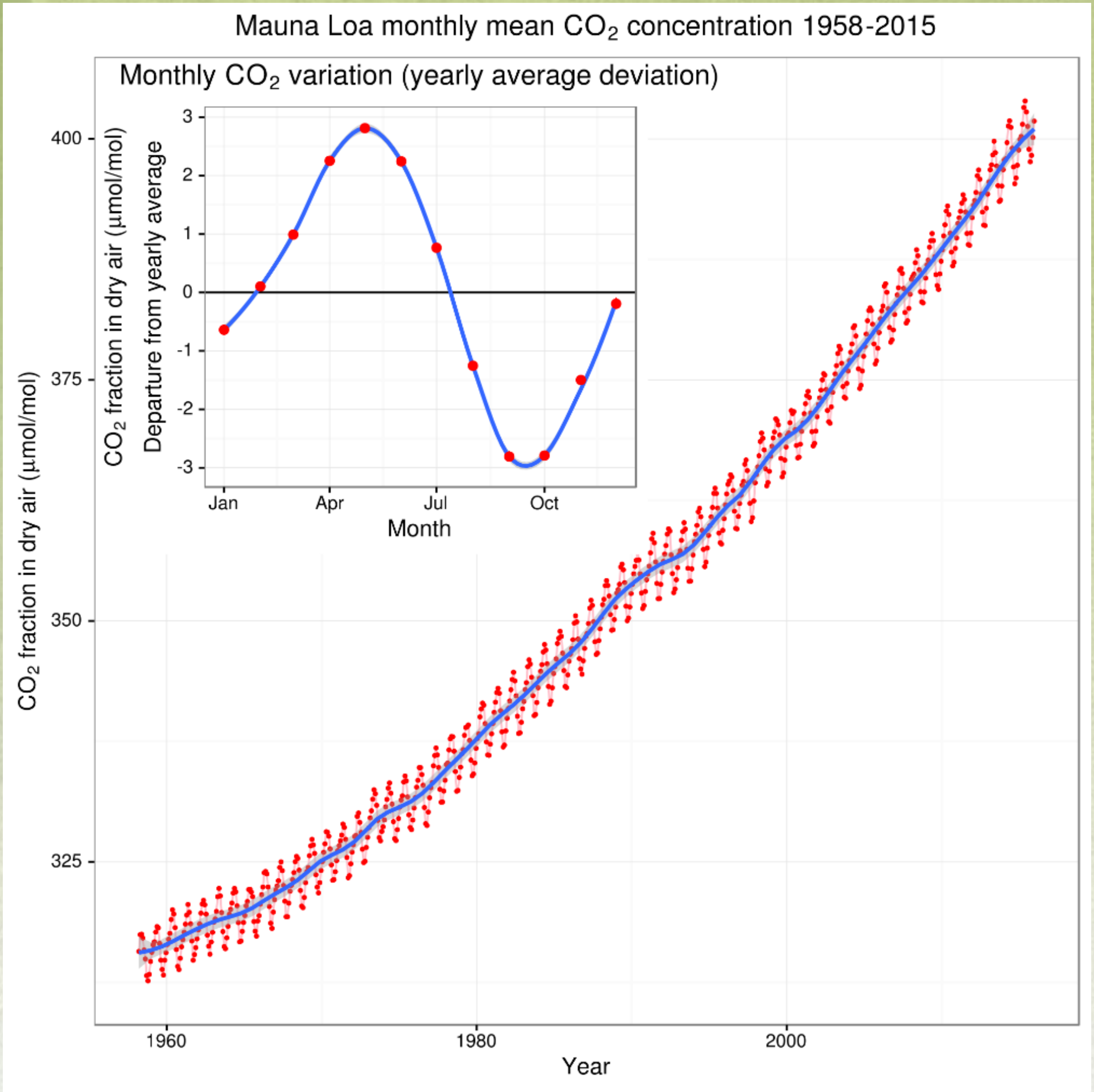


1982 – 2007:

- 41M acres lost to development
- 23M acres of that was active farm land

Feeding the world with less available land

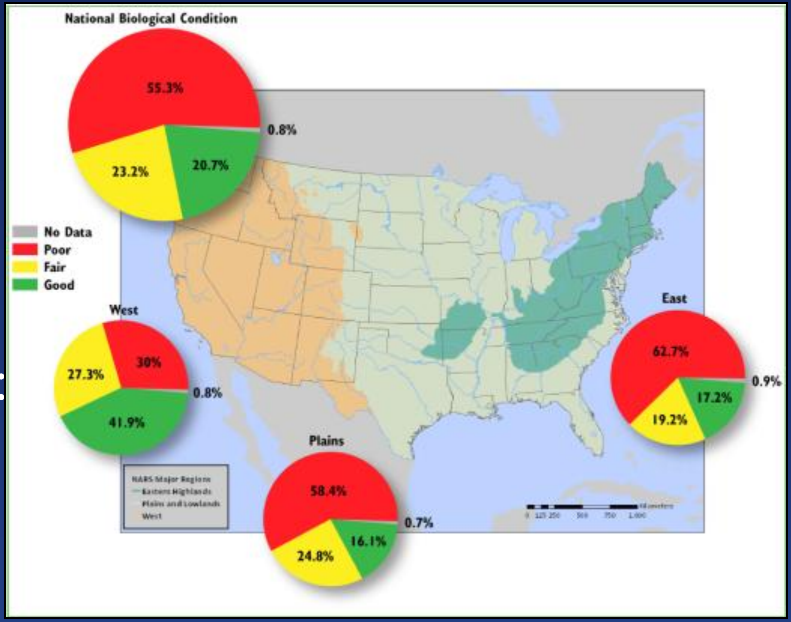



Mauna Loa monthly mean CO_2 concentration 1958-2015
Monthly CO_2 variation (yearly average deviation)
CO_2 fraction in dry air (µmol/mol)
Departure from yearly average
3
2
1
0
-1
-2
-3
Jan
Apr
Jul
Oct
Month
CO_2 fraction in dry air (µmol/mol)
400
375
350
325
1960
1980
2000
Year

Water: The right amount at the right time

National Water Quality Challenges

- Biological conditions of nation's rivers and streams
  - Poor – 55.3%
  - Fair – 23.3%
  - Good – 20.7%
  - Unknown – 0.8%
- Greatest stressors:
  - Phosphorous
  - Nitrogen
  - Riparian cover and disturbance
  - Streambed sediment
  - Enterococci



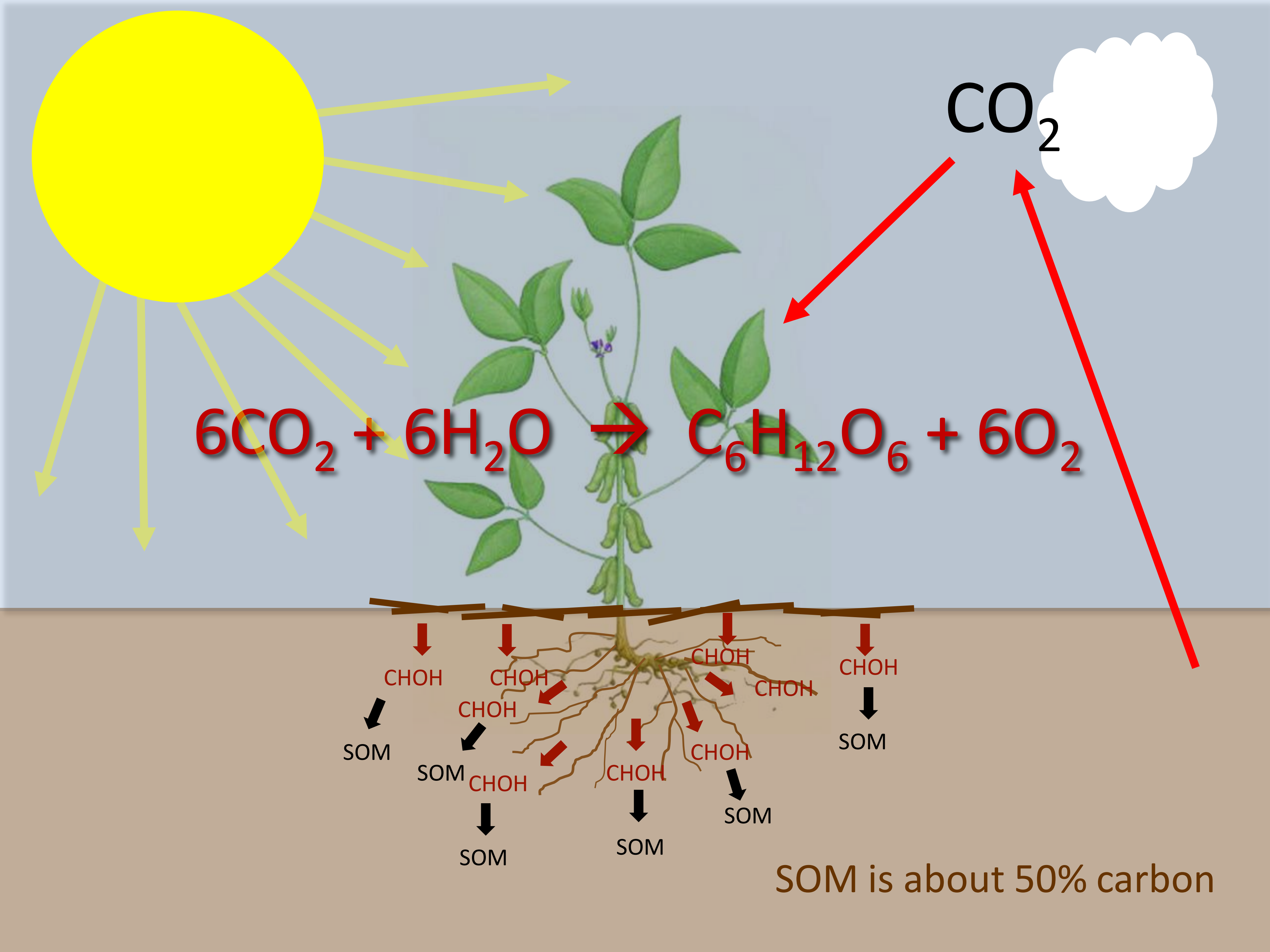
Biological condition of the nation's rivers and streams, based on the Macroinvertebrate Multimetric Index. From National Rivers and Streams Assessment (2008-2009) (EPA, 2013.)

Agriculture's role in addressing the challenges

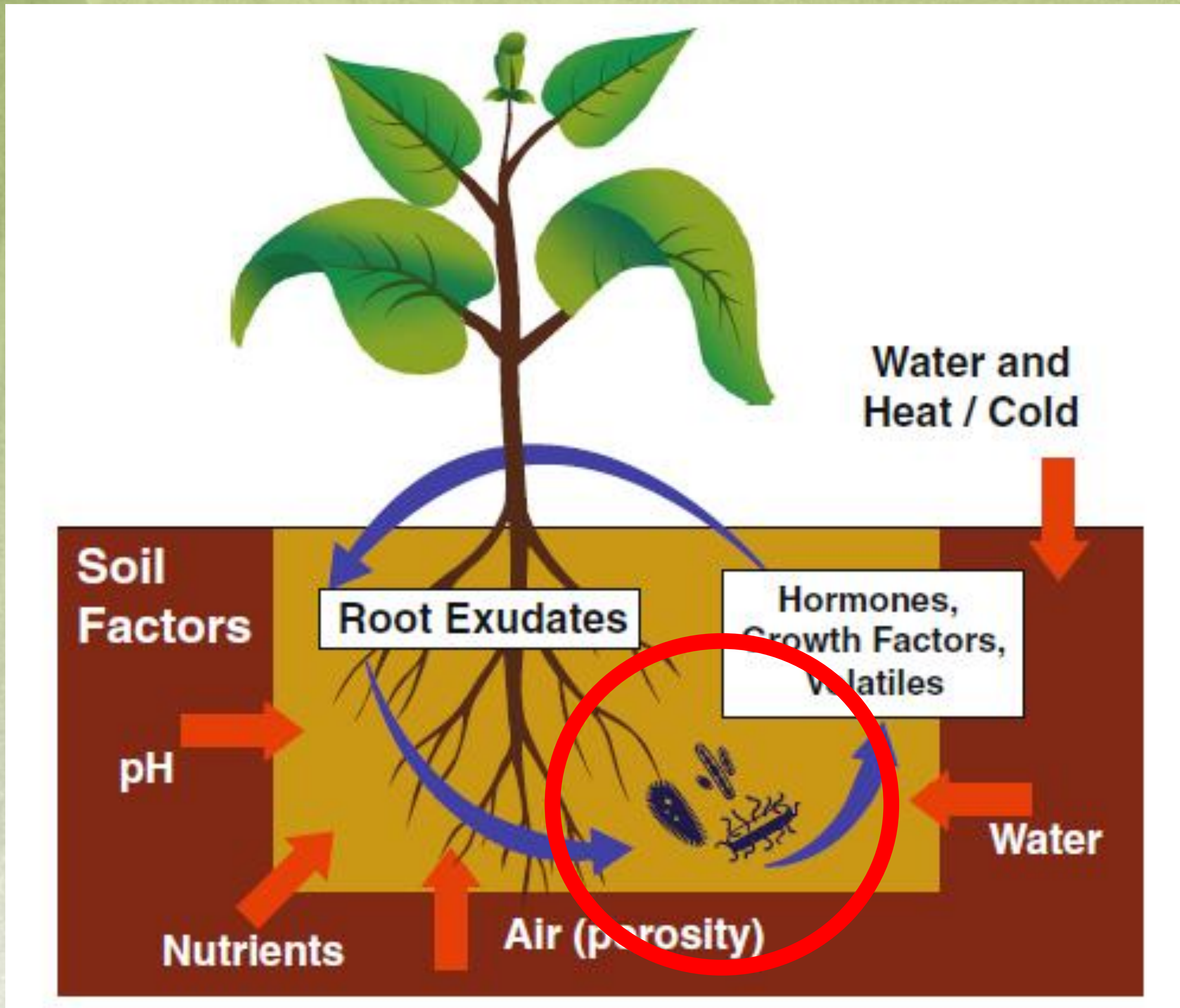
Natural systems differ from crop systems in:

- hydrology
- soil biological activity & function
- nutrient cycling
- amount of C sequestered

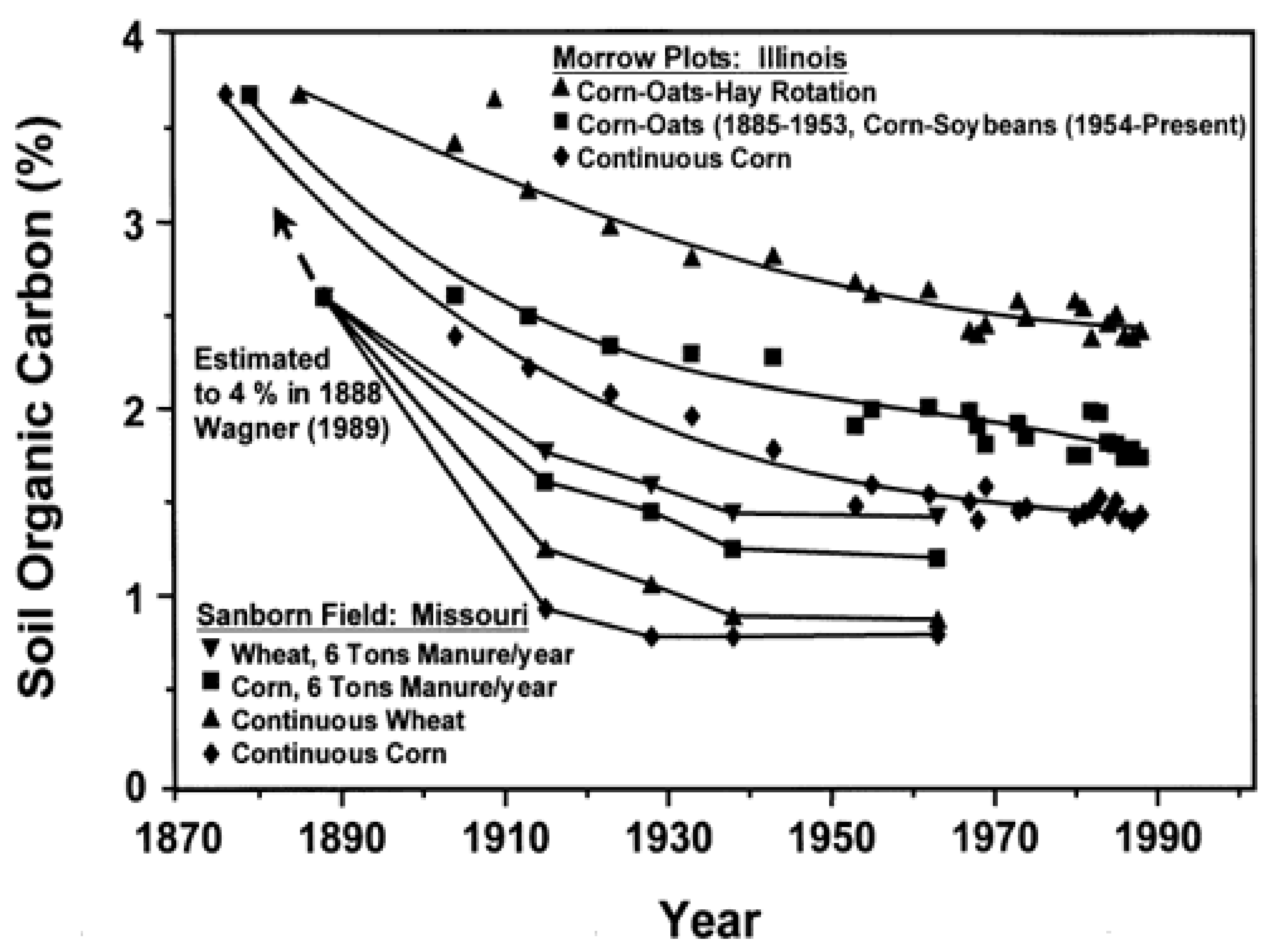
- soil temperature
- plant health and susceptibility to pests
- system resistance and resilience



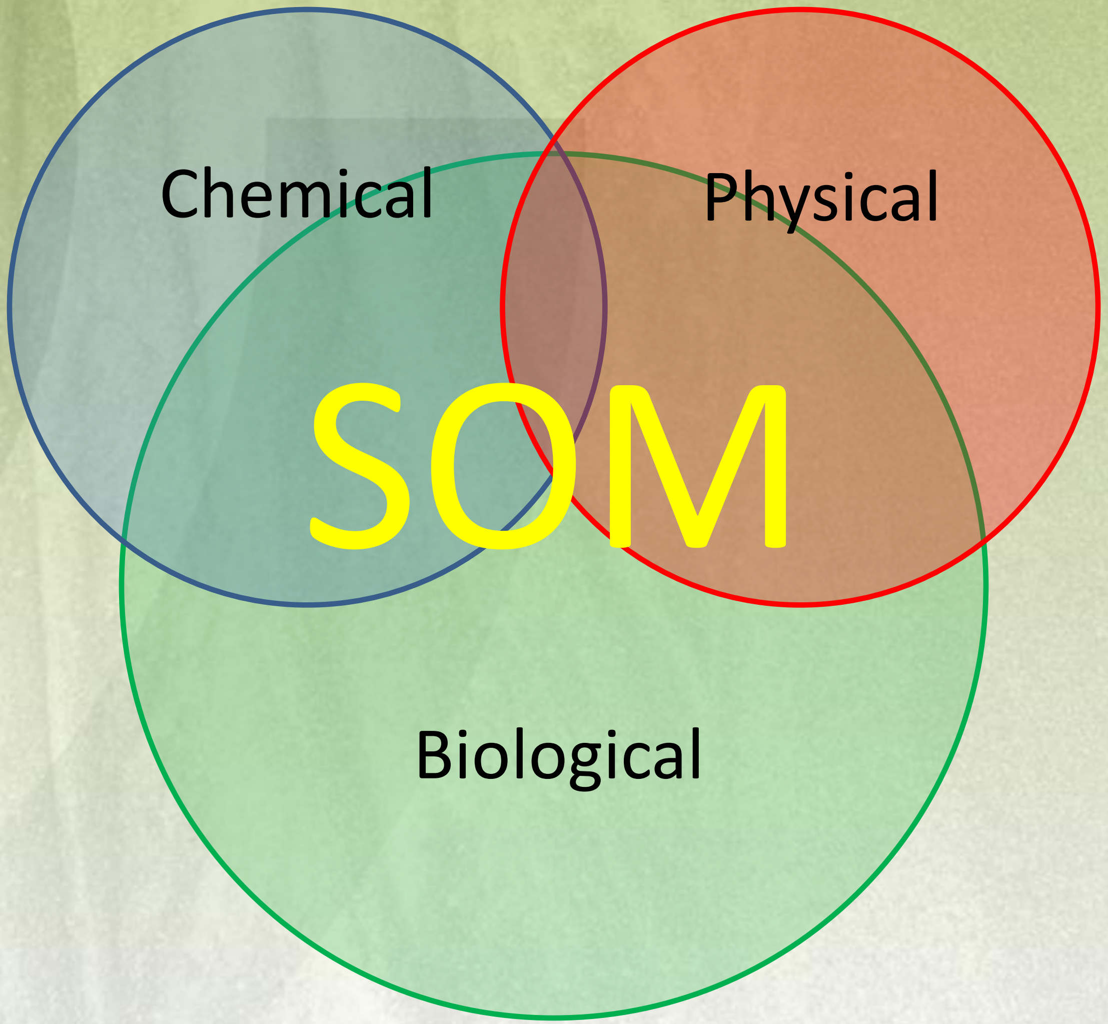
CO_2
$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
CHOH
CHOH
CHOH
CHOH
CHOH
CHOH
CHOH
CHOH
CHOH
SOM
SOM
SOM
SOM
SOM
SOM
SOM is about 50% carbon



Chaparro, et al. 2012. Biology and Fertility of Soils


Soil Organic Carbon (%)
Year
Morrow Plots: Illinois
Corn-Oats-Hay Rotation
Corn-Oats (1885-1953, Corn-Soybeans (1954-Present)
Continuous Corn
Estimated
to 4 % in 1888
Wagner (1989)
Sanborn Field: Missouri
Wheat, 6 Tons Manure/year
Corn, 6 Tons Manure/year
Continuous Wheat
Continuous Corn
0
1
2
3
4
1870
1890
1910
1930
1950
1970
1990

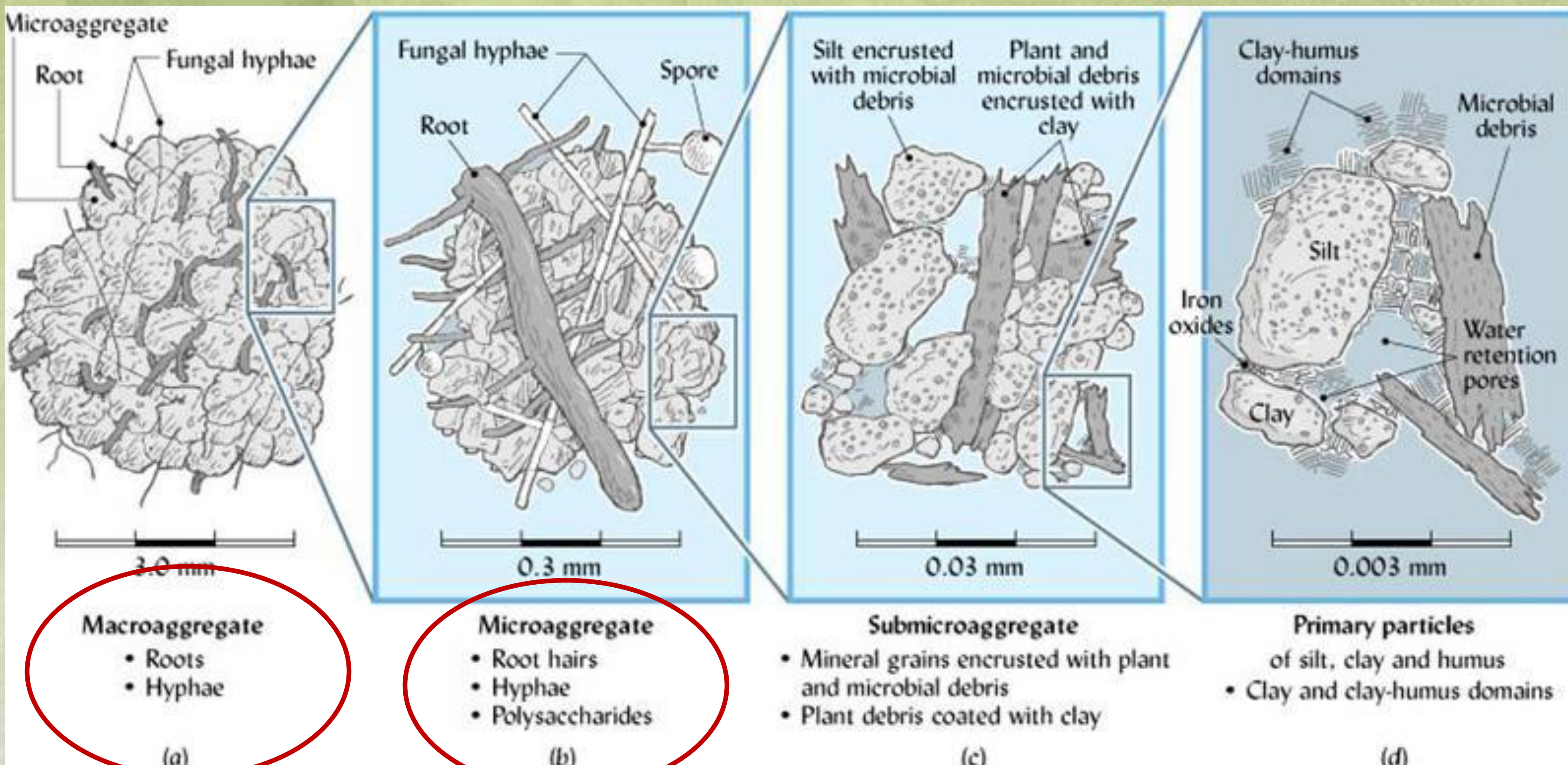
Interrelated soil systems



The role of soil microbes in the function of agricultural systems

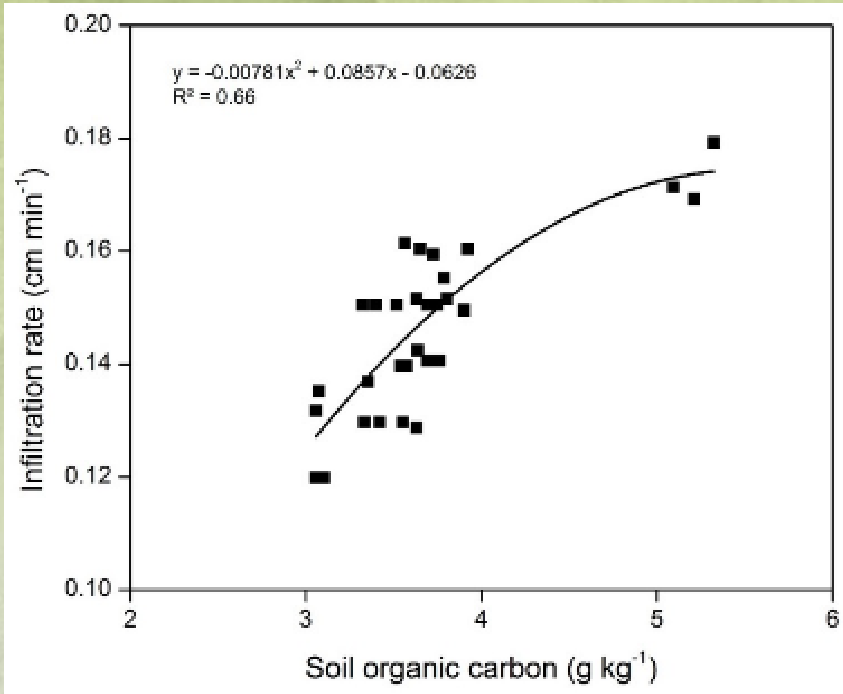
- Importance of soil microbial community
  - Nutrient cycling
  - Nutrient retention and water capture
  - Disease suppression
  - Aggregate formation and stability– hyphae and bacterial byproducts and remnants
  - Food for the rest of the soil fauna

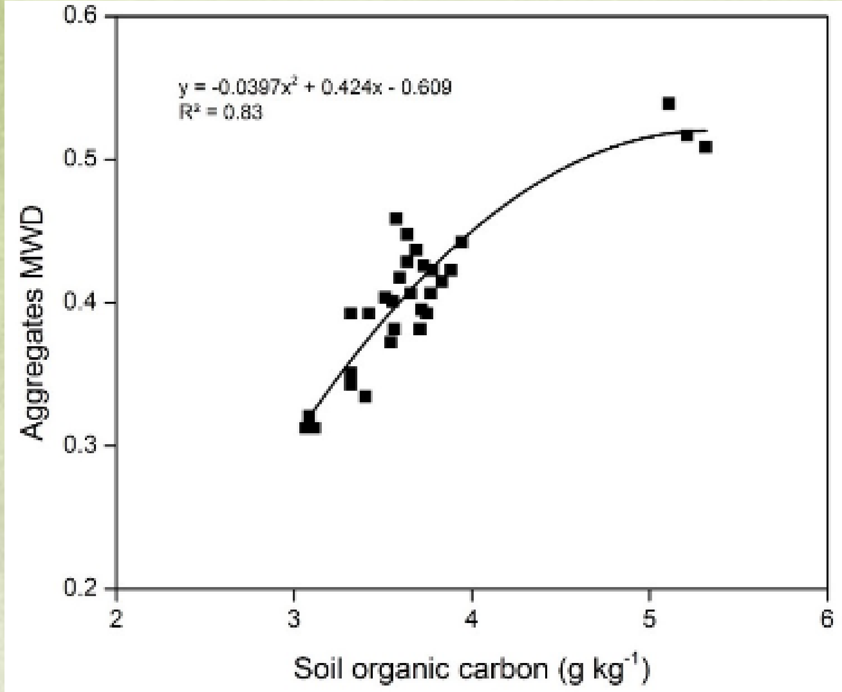
The biological component of aggregation



Brady & Weil. 2008. The Nature and Properties of Soils

Carbon, aggregates and infiltration





Brar, et al. 2015. *Agronomy* (5)

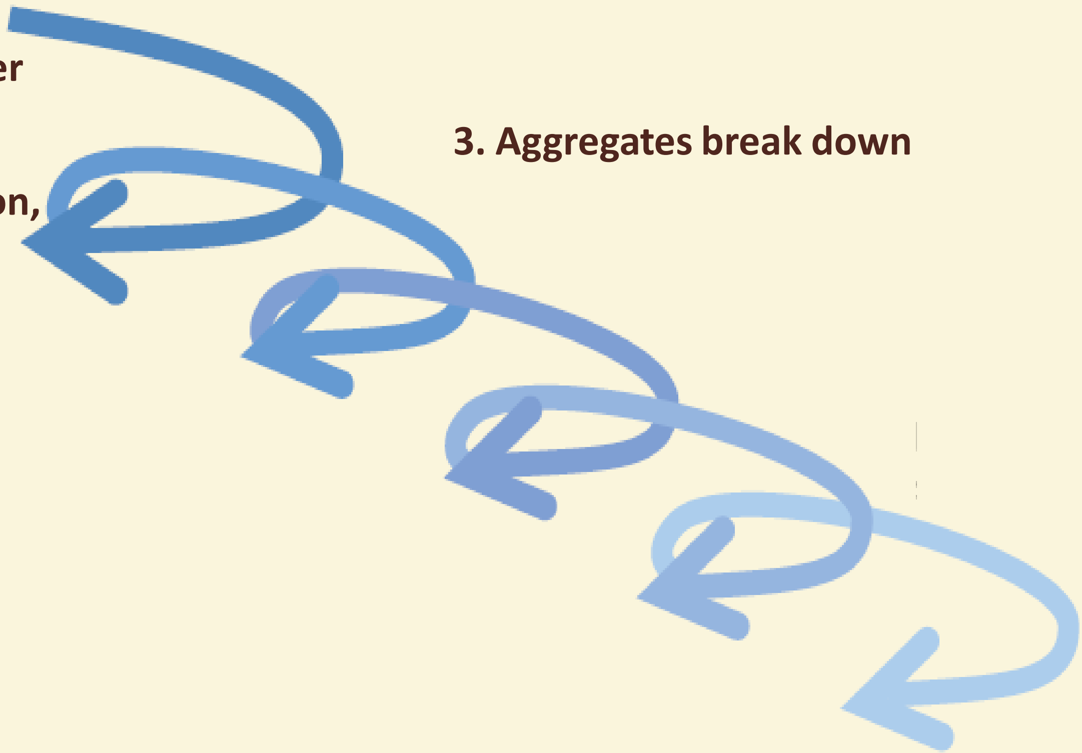
Downward Spiral of Soil Degradation

in annual systems

1. Intensive tillage, insufficient added residues, low diversity, no surface cover

2. Soil organic matter decreases, erosion, subsoil compacted

3. Aggregates break down



Modified from *Building Soils for Better Crops*

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5. Infiltration decreases
Erosion by wind and water increases

6. More soil organic matter, nutrients, and top soil lost

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7. MORE ponding & persistent wetness, but LESS soil water storage; less rooting; lower nutrient access by plants; less diversity of soil organisms, more disease

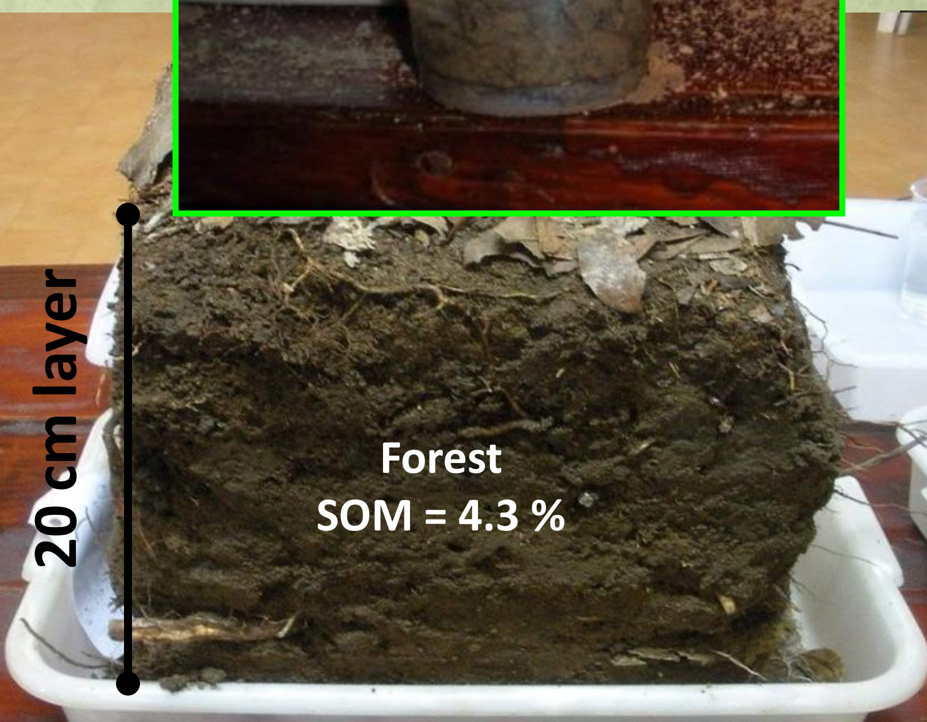
8. Crop yields decline

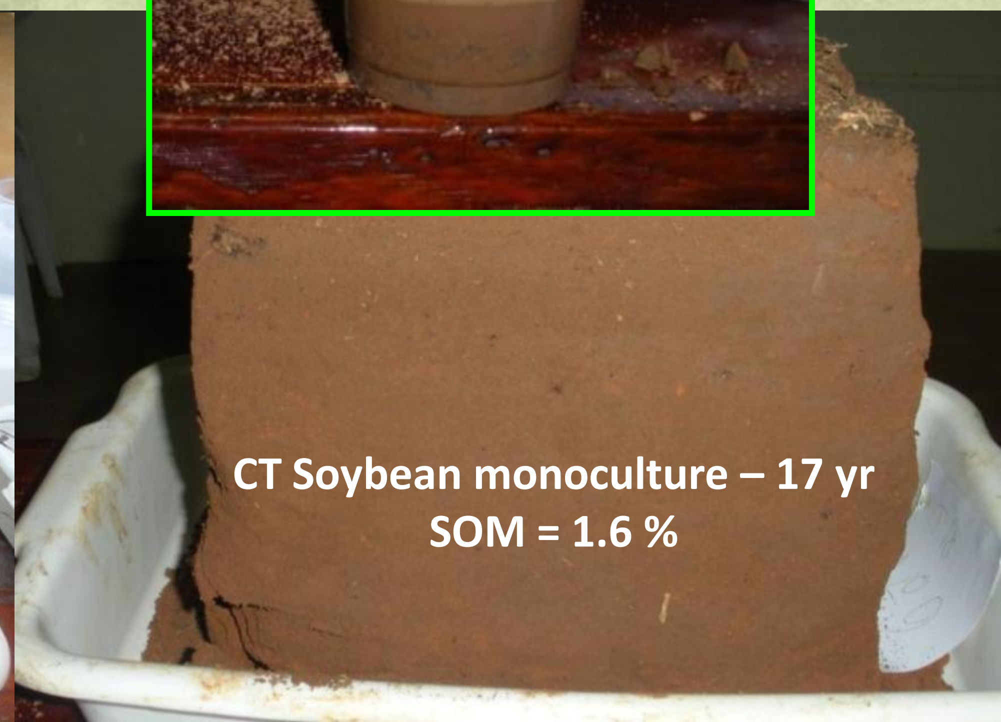
9. Hunger and malnutrition, especially if little access to inputs

Modified from *Building Soils for Better Crops*

Management affects soil properties & function

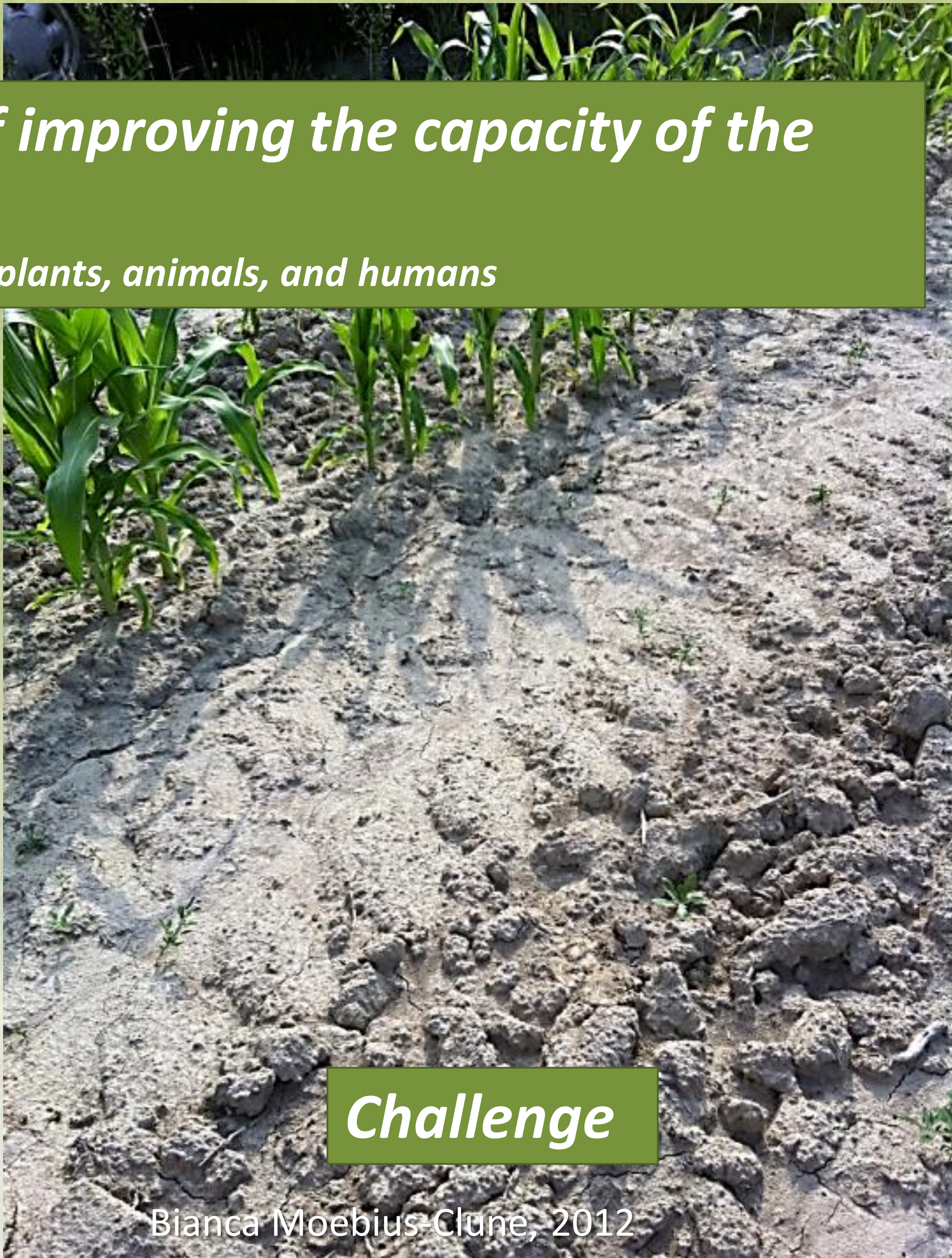
63% decrease in soil organic matter after 17 years of conventionally-tilled monoculture





Soil Health: the process of improving the capacity of the soil to function

as a vital living ecosystem that sustains plants, animals, and humans



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USDA

United States Department of Agriculture

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Fact Sheet

April 13, 2016

USDA's Building Blocks for Climate Smart Agriculture & Forestry – Fact Sheet

Today, the U.S. Department of Agriculture is announcing a comprehensive and detailed approach to support farmers, ranchers, and forest land owners in their response to climate change. The framework consists of 10 building blocks that span a range of technologies and practices to reduce greenhouse gas emissions, increase carbon storage, and generate clean renewable energy. USDA's strategy focuses on climate-smart practices designed for working production systems that provide multiple economic and

USDA's strategy is made of these 10 building blocks:

Soil Health: Improve soil resilience and increase productivity by promoting conservation tillage and no-till systems, planting cover crops, planting perennial forages, managing organic inputs and compost application, and alleviating compaction. USDA aims to increase no-till implementation from the current 67 million acres to over 100 million acres by 2025.

USDA
United States Department of Agriculture

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News Release

Agriculture Secretary Vilsack Announces Climate Smart Agriculture and Forestry Results, Additional $72.3 Million Soil Health Investment to Support Paris Agreement

WASHINGTON, May 12, 2016 – Today, Agriculture Secretary Tom Vilsack shared the first results of USDA's Building Blocks for Climate Smart Agriculture and Forestry, one year after he unveiled the plan at Michigan State University. In addition to providing specific goals and results of the many actions that USDA is taking to help farmers, ranchers, and forestland owners respond to and help mitigate climate change, Vilsack announced a new $72.3 million investment to boost carbon storage in healthy soils.

Healthy soils store carbon

Carbon Plan Description and Requirements
Revised 3/8/16

Definition and Purpose

A carbon plan is a whole-farm conservation plan that when implemented will enhance soil health, increase carbon sequestration and reduce greenhouse gas (GHG) emissions. The planner and client develop the carbon plan by addressing resource concerns on the farm or ranch through application of targeted, site-specific conservation practices. The carbon plan contains all the elements of a conservation plan including an inventory and analysis of current resource conditions, on-farm carbon sequestration and GHG mitigation potential, and the client's decision regarding the implementation of a conservation system that will address the identified resource concerns.

Requirements for the Carbon Plan

1. The plan will address the following for each land use. See attached Appendix for land use definition.

Cropland

a. At a minimum, address the NRCS planning criteria for:

- Soil quality: Soil organic matter depletion and available water holding capacity.
- Insufficient water: Inefficient moisture management
- Air quality: Emissions of greenhouses gases (nitrous oxide, methane, and carbon dioxide)

Storing C in agricultural soils

- Georgia USA Coastal Plain
- Fine to fine-loamy, kaolinitic, thermic, Kandiudults
- Converted annual cropland to high-intensity grass-based dairies
- ~75% increase in soil C within 6 years
- Increase CEC 95% and WHC 34% in top 30 cm

Machmuller, et al. 2015. Nature Comm.

Can management increase SOM in a Mediterranean climate?

- Sierra Foothills
  - 40 acres of orchard with some annual crops
  - Permanent covers, heavy mulches, no tillage
  - Increased SOM at 0 – 12 inches from avg. of **2.2 to 5.1%** in 30 years
- Sacramento Valley
  - ~2000 acres of annual vegetables
  - Tillage for weed management, diverse rotations, covers, organic amendments
  - Increased SOM from avg. of **<2.0 to 3.8%** in 19 years

Can management increase SOM in a Mediterranean climate?

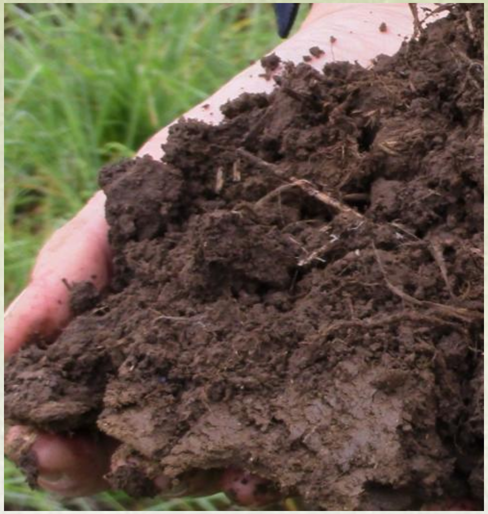
- San Joaquin Valley
- Vina fine sandy loam
- Coarse-loamy, mixed, superactive, thermic Pachic Haploxerolls

Can management increase SOM in a Mediterranean climate?

- After 18 years
- Mixed cover crop
- Minimum soil disturbance
- Periodic compost additions

→Increased WHC, reduced N applications, improved nut quality

0.9% SOM



4.0% SOM

How do we improve the health of agricultural soils?

- Minimize tillage and other disturbance
- Keep the soil surface continually covered
- Have growing plants present as much as possible
- Increase plant diversity
- Properly manage nutrients and pesticides

THE CHALLENGE: How do we adjust the general principles for specific regions and systems?

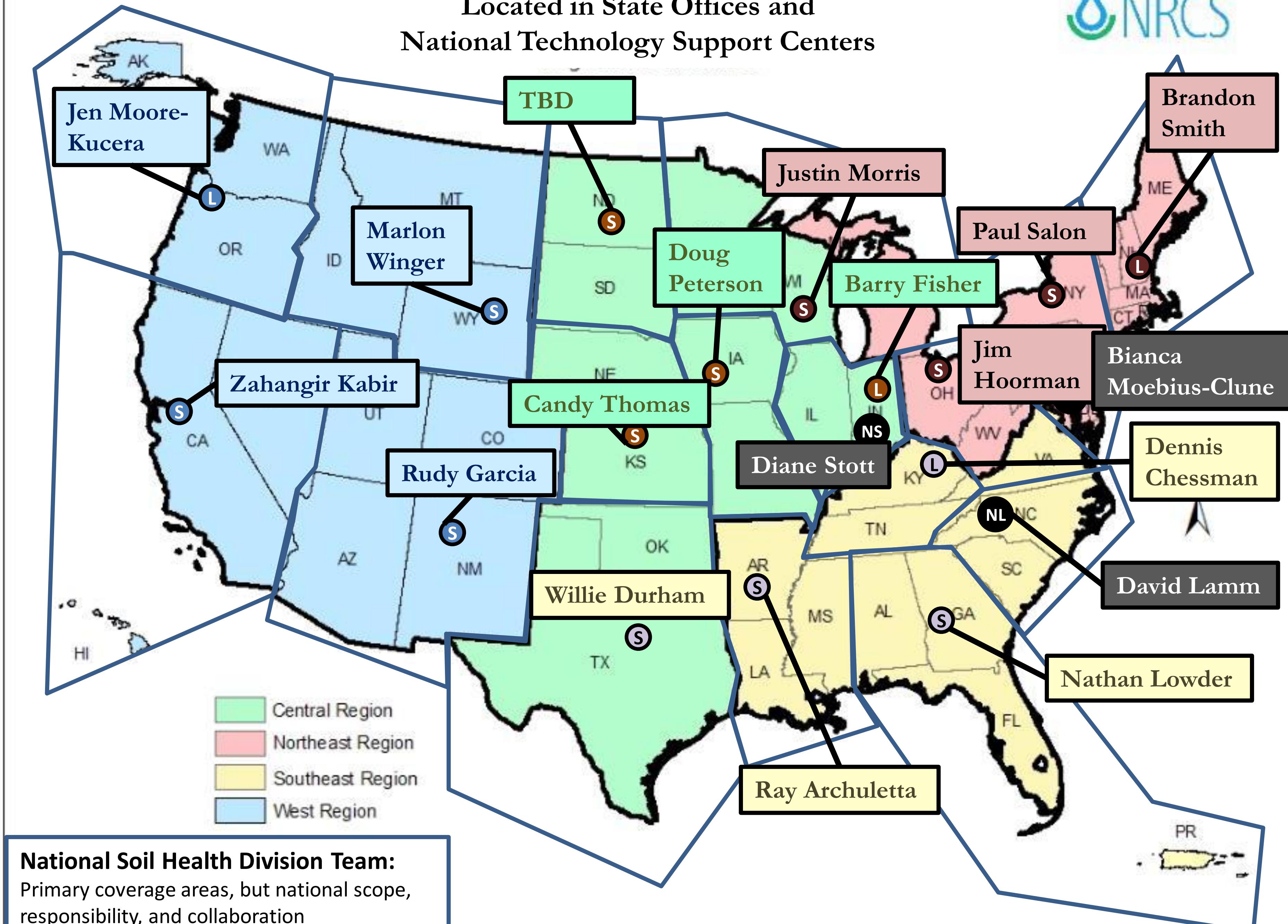
How do we get there?

- Education: help producers and service providers understand basic processes
- Assessment: current conditions and potentials
- Cooperation: identify appropriate regional systems
- Quantify economics
- Training: NRCS planners and conservation partners
- Planning and implementation: assistance to State, Area and FOs

Photos: NRCS and Dorn Cox, 2012

NRCS Soil Health Division Staff

Located in State Offices and National Technology Support Centers



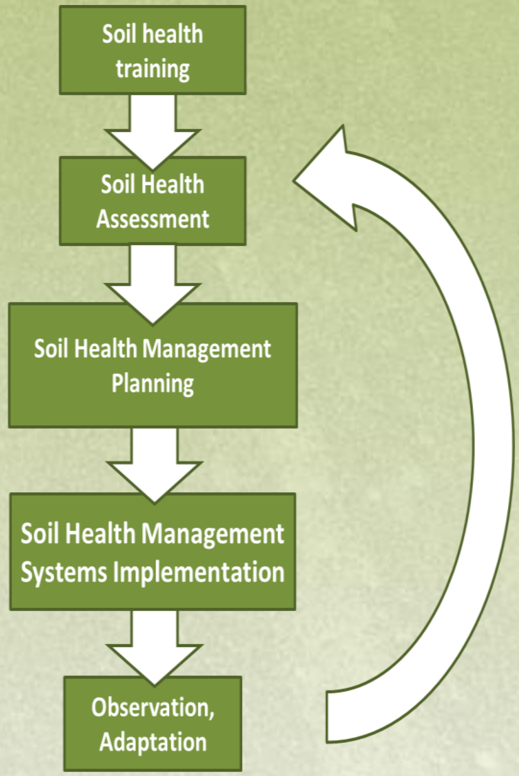
National Soil Health Division Team:
Primary coverage areas, but national scope, responsibility, and collaboration

What will the SH Division do?

- The SHD will lead a national effort for the widespread adoption of ecosystem-improving soil health management systems through training, outreach, and cooperation with conservation partners.

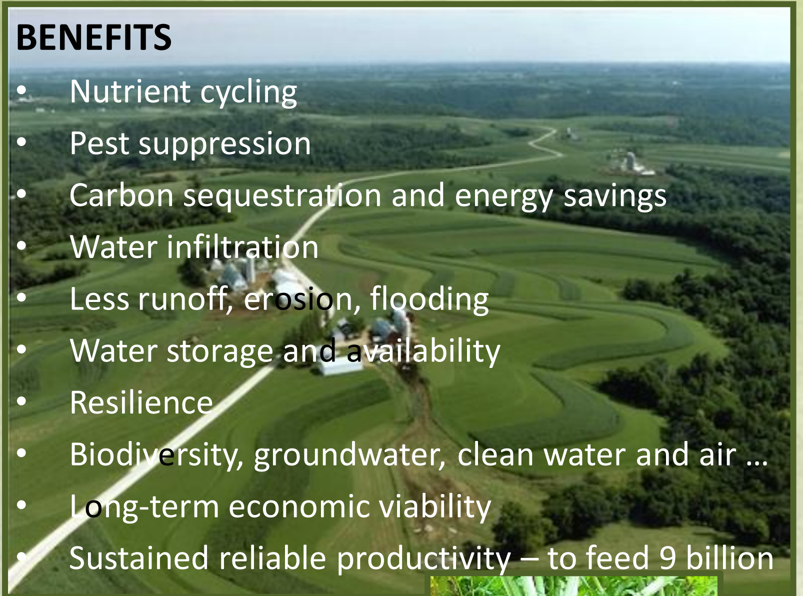
What will the SH Division do?

- Build & leverage partnerships
- Identify appropriate soil health management systems that are area and crop specific
- Compile, develop, & provide advanced training & materials, assess knowledge gaps
- Provide direct consultative assistance
- Facilitate development and acquire new technologies & approaches for the agency
- Develop & revise NRCS standards to facilitate successful soil health management systems implementation on farms and ranches



Return on our soil health investment

Changing the Face of Agriculture

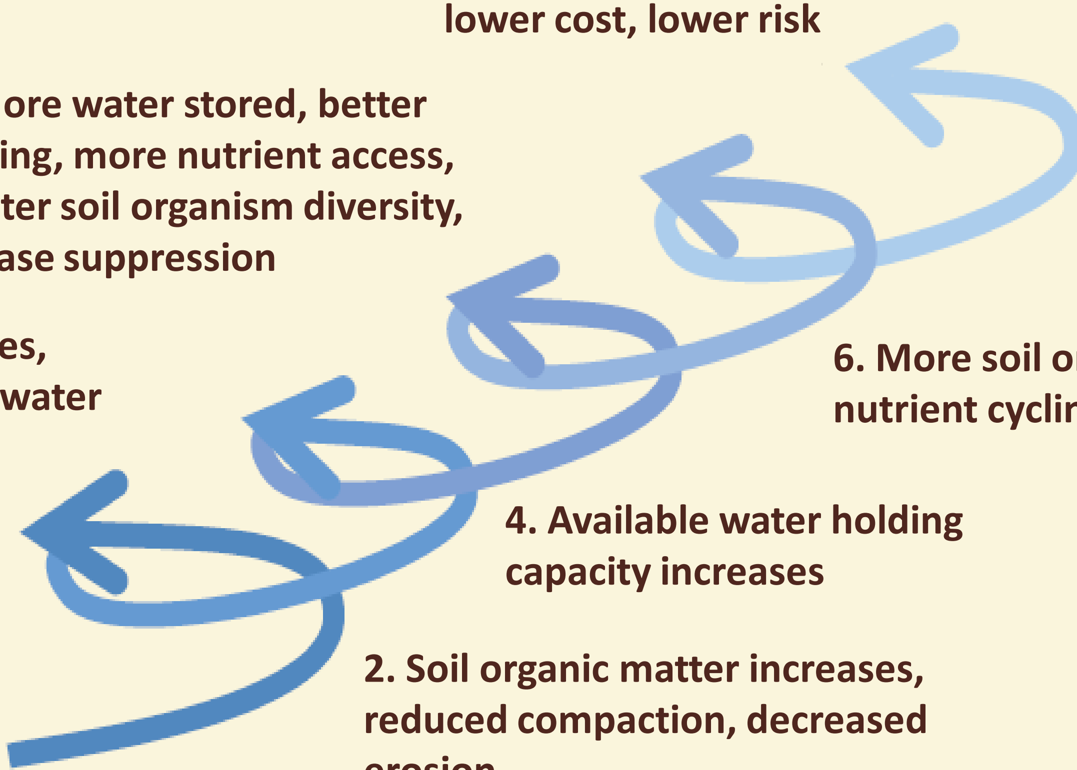


BENEFITS

- Nutrient cycling
- Pest suppression
- Carbon sequestration and energy savings
- Water infiltration
- Less runoff, erosion, flooding
- Water storage and availability
- Resilience
- Biodiversity, groundwater, clean water and air …
- Long-term economic viability
- Sustained reliable productivity – to feed 9 billion

Photos: NRCS and Dorn Cox, 2012

WIN-WIN regenerative management systems for healthy soils



What should farming in the future look like?

Comments?

Collaboration in the South and PR

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